# From State of Science to State of the Art Reliability

Daniel KANZLER [1]
[1] Applied Validation of NDT, Berlin, Germany

Contact e-mail: KanzlerD@av-ndt.com
Malplaquetstraße 14a, 13347 Berlin

**Abstract**

Probabilistic evaluations, in the form of Probability of Detection (POD) or Receiver Operating Characteristics (ROC), have their origin in evaluating testing systems for spacecraft and military aircrafts. Over the last five decades, other domains (civil engineering, petrochemical industry, railway, electricity generation and the final deposit of spent nuclear fuel) used these approaches and developed highly sophisticated methods to evaluate their testing systems. The scientific approach allows a precise evaluation of sophisticated testing systems, such as the semi-automated phased array ultrasonic testing equipment.

Although the knowledge is there and could be used to improve the testing processes, could be customized to the specific needs of the client, and would provide a realistic image of the testing process, lots of companies use non-destructive testing methods without knowing the ability of their system. This is because the companies are either not aware of the knowledge, find it too complex for their application, or because of the high costs associated with the evaluation. This paper will show that there are tools (within the design of experiments and statistical models) that can be used to obtain an understandable probabilistic evaluation of the testing process and means for optimization that meet the needs even of small companies.

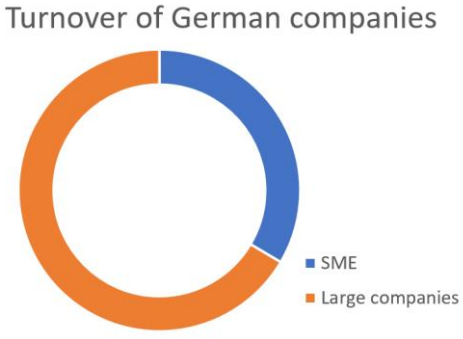
APPLIED VALIDATION

What are the future requirements for reliability

# From State of Science to State of the Art Reliability

Dr. Ing. Daniel KANZLER

## Probabilistic evaluation for everyone



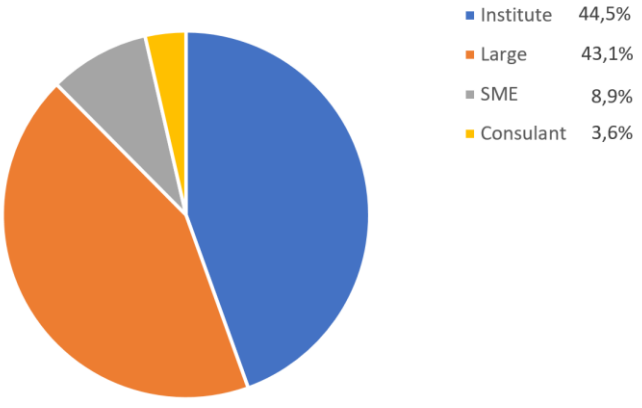

Role of small and medium enterprises (SME) for large companies:

- Suppliers
- Outsourced companies
- Extended workbench

René Söllner 2014: Die wirtschaftliche Bedeutung kleiner und mittlerer Unternehmen in Deutschland

## Are SME using reliability models to guarantee global quality?

Portion of SME companies publishing articles about POD




Source: Evaluation of a sample size of over 250 publications about Reliability

## Use of reliability methods in SME

Why are SME not using reliability tools:

- High costs of Design of Experiments and Probability of Detection studies
- Missing knowledge due to
  - small amount of courses
  - available free software
  - few understandable literature for beginners
- Missing personal for the evaluation

➔ SME need more help and other requirements in the topic of reliability methods

## How much does quality cost?

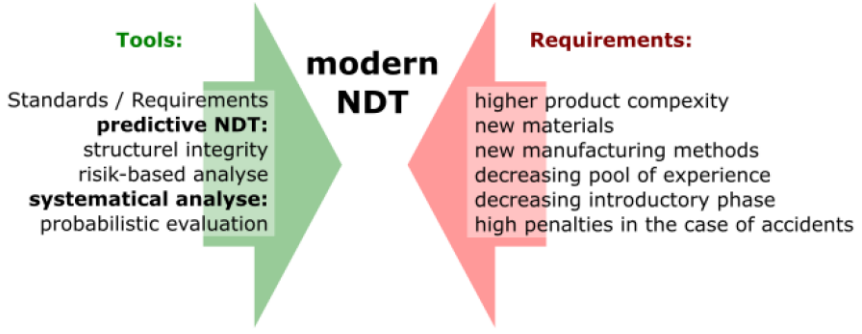
The costs of quality problems will rise approximately **around 30%**.

The expected costs of the quality risk might be around

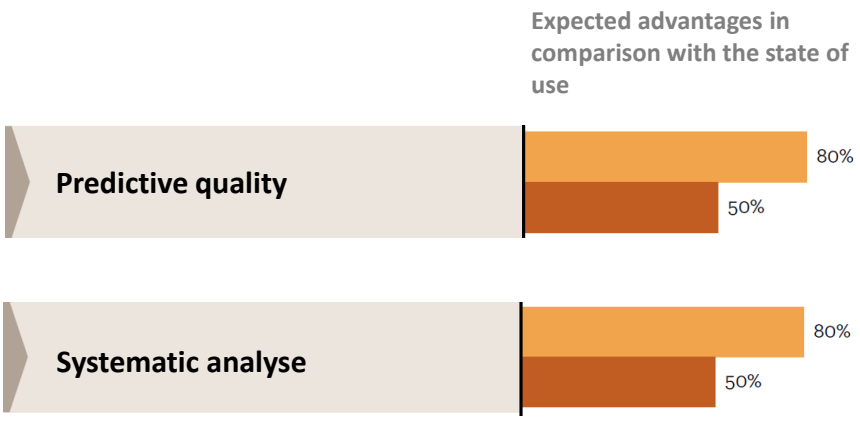
215 Mrd. US Dollar

Qualität 4.0 als Antwort auf die 215 Milliarden Dollar Herausforderung (März 2017) https://www.atkearney.de/

## Requirements of the modern NDT situation



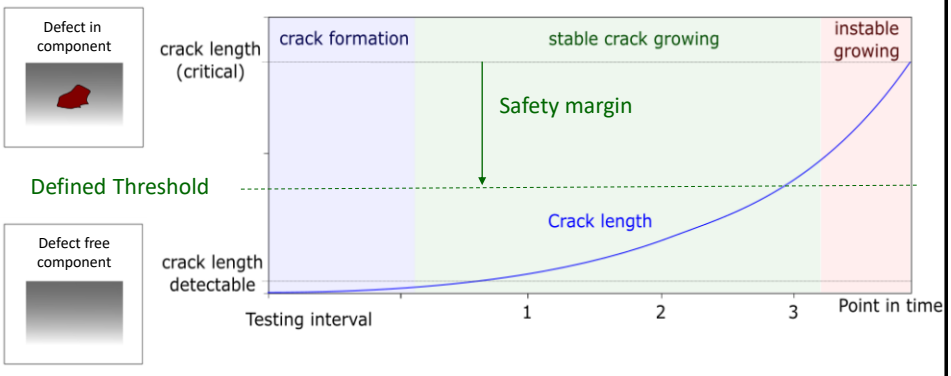
## State of the use of innovative quality tools



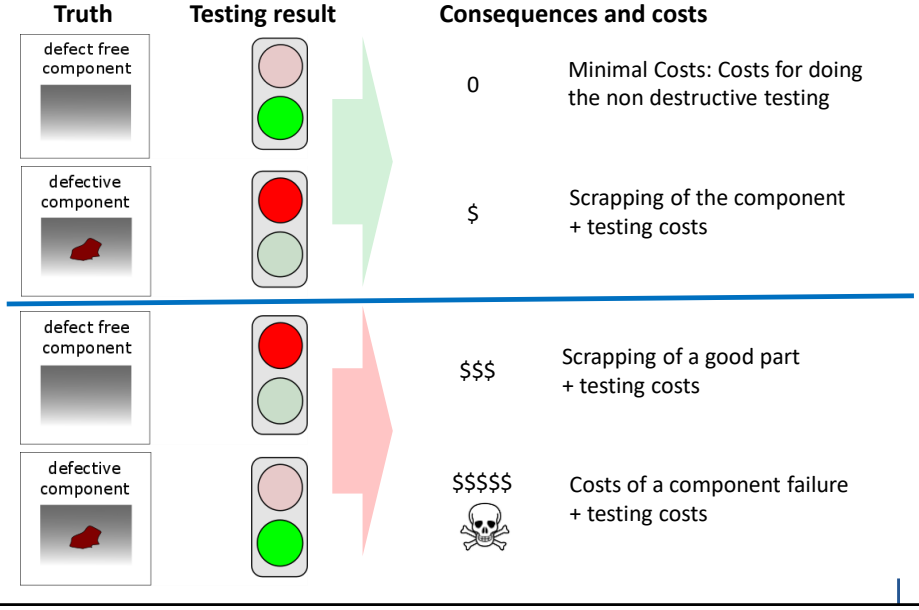

Qualität 4.0 als Antwort auf die 215 Milliarden Dollar Herausforderung (März 2017) https://www.atkearney.de/

1. Basic tool for a first sign of reliability

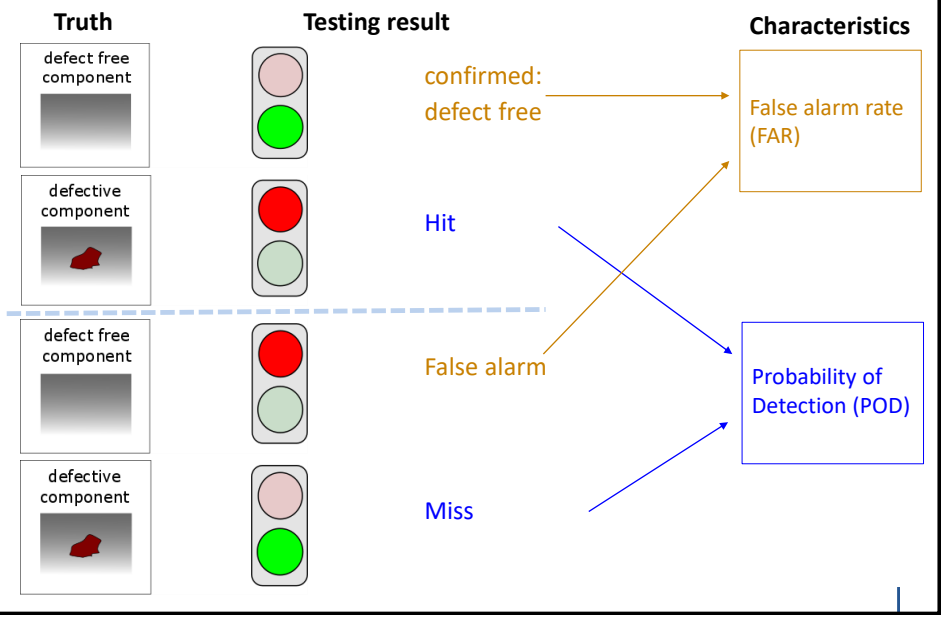
## Definition of finding defects



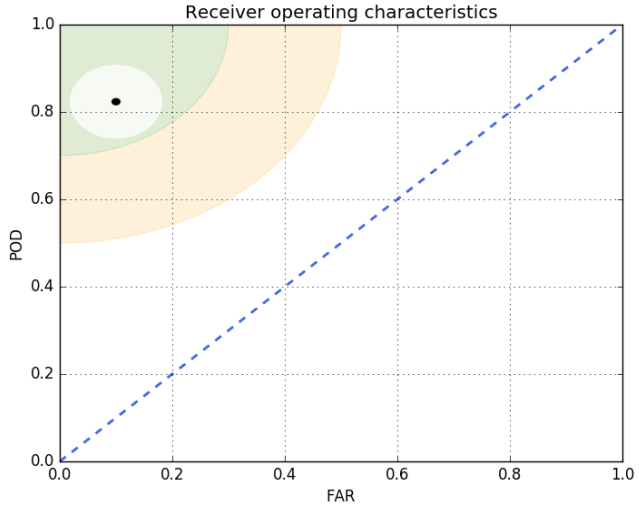

## Consequences of testing results



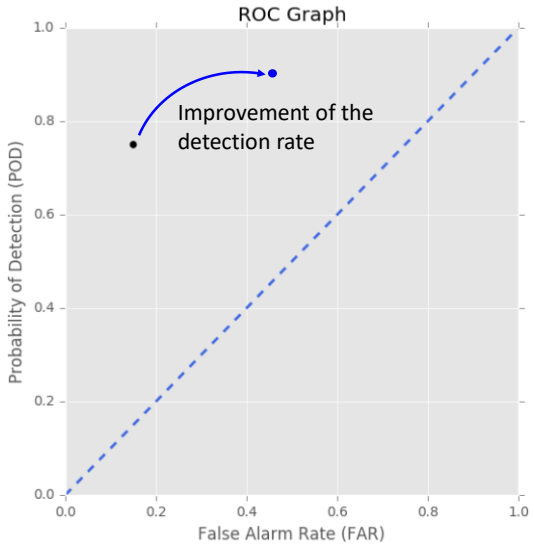
## Useful Characteristics



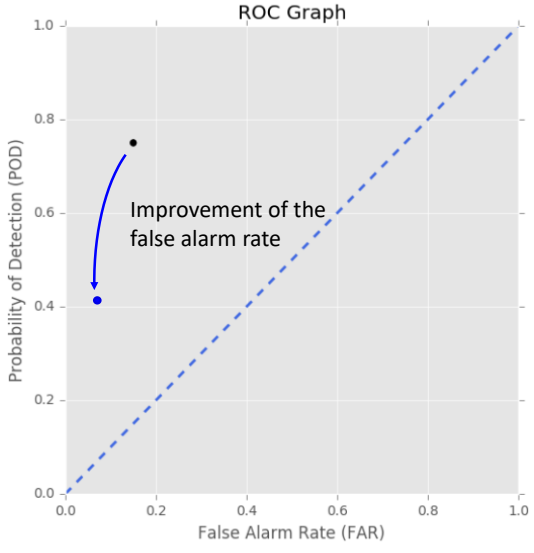

## Evaluation of critical defects



## Working point I: Improving the POD



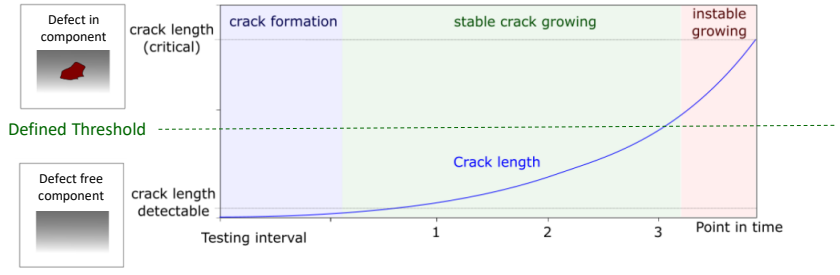

## Working point II: Improving the FAR



## Advantages for ROC

- The ROC methods are useful for SME:
  - easy to understand
  - easy to use
- Basic information about reliability
  - Probability of Detection
  - False Alarm Rate
  - for a specific critical defect
- Widely used in different areas
  - Medicine
  - Signal theory

## Systematically analysis and predictive quality

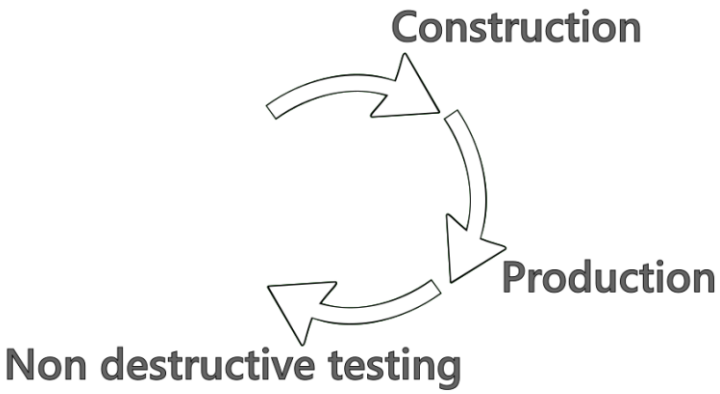



- Understanding the decision threshold
  - Depending on the testing task (criticality and costs)
  - Depending on the capability and reliability of testing system

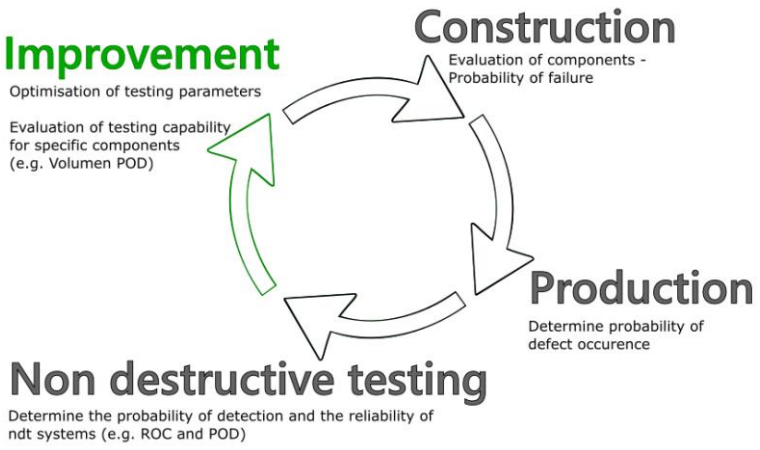
Probabilistic evaluation methods can help for the construction and planning for testing interval

2. Changing the role of NDT
from expensive “black sheep“
to money-saving “guardian angel”

## State of the production environment

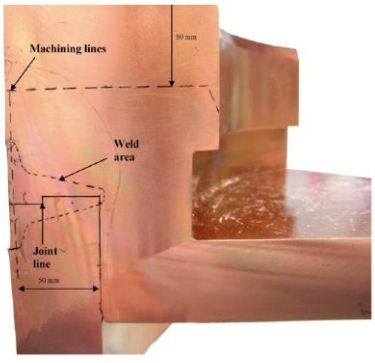


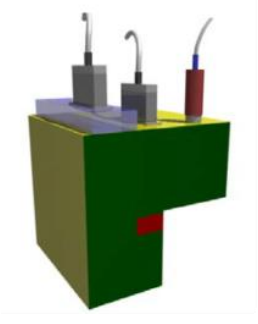
## Future Orientation of NDT




## Changings of the construction after reliablity evaluations

Improvements through the changing of the geometry and the process of production and the optimation of the used testing methods

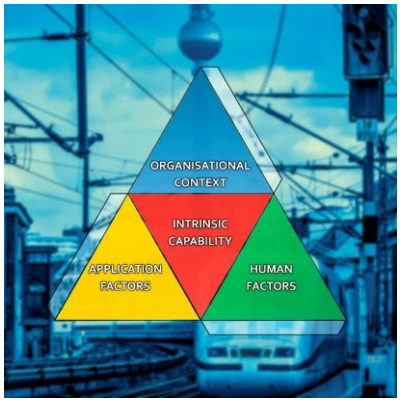


Volume POD for the evaluation of the testable areas

3. Future of Reliability and ROC

## Conferences and Workshops




European-American Workshop on Reliability of NDE

- Open Space  Technology (OST)
- Break Out Session
- Discussions

## Internationally working with POD

ICNDT International Specialist Group – NDT Reliability
National and international working groups about the topic “Reliability”
Topic specific groups e.g. MaPOD Groups

To solve problems like:

- MaPOD
- Technical justification
- Kind of defects: artificial, realistic, real
- In service based POD
- Structural Health Monitoring POD
- Human Factors

**Thank you for your attention.**
**Any questions?**

*For further information:*

APPLIED VALIDATION
E – info@av-ndt.com
T – 0159 04542678
W – www.av-ndt.com